WHAT IS CLAIMED IS:

1. A filament winding apparatus for winding a fiber bundle onto a structure, comprising:

a fiber bundle application section, wherein the fiber bundle application section further comprises:

a spool section comprising at least one fiber bundle spool; and

a winding head comprising a spreading assembly;

a transport to move the fiber bundle application section; and

a controller for applying the fiber bundle on the structure.

2. The filament winding apparatus of claim 1, further comprising a mandrel supporting the structure.

3. The filament winding apparatus of claim 1, wherein the spool section further comprises:

an idler rod to control the tension in the fiber bundle.

4. The filament winding apparatus of claim 1, wherein the spool section further comprises:

an articulator to rotate the spool section.

5. The filament winding apparatus of claim 1, wherein the fiber bundle application section further comprises:

a winding head rotator to rotate the winding head.

6. The filament winding apparatus of claim 1, wherein the spreading assembly further comprises:

a plurality of rods arranged to spread each fiber bundle entering the winding head.

7. The filament winding apparatus of claim 6, wherein the winding head further comprises:

a frame having a top and bottom;

at least one winding eye disposed on the top of the frame; and

a roller disposed on the bottom of the frame.

8. The filament winding apparatus of claim 7, wherein the rods, winding eye, and roller are arranged to spread each fiber bundle entering the winding head and to arrange the spread fiber bundles in a side-by-side parallel manner.

9. The filament winding apparatus of claim 6, wherein at least one of the rods is curved.

10. The filament winding apparatus of claim 6, wherein at least one of the rods rotates.

11. The filament winding apparatus of claim 1, further comprising a resin applicator to apply resin to the fiber bundle.

12. The filament winding apparatus of claim 11, wherein the resin applicator further comprises:

a resin container;

a resin hose connected to the resin container; and

a resin dispenser.

13. The filament winding apparatus of claim 12, wherein the resin container is heated.

14. The filament winding apparatus of claim 12, wherein the resin applicator further comprises a resin metering drum to instruct the resin container to provide a measured quantity of the resin to the resin dispenser.

15. The filament winding apparatus of claim 1, wherein the controller moves the transport to apply the fiber bundle on the structure in a predetermined location.

16. The filament winding apparatus of claim 2, wherein the controller moves the transport and rotates the mandrel to apply the fiber bundle on the structure in a predetermined location.

17. The filament winding apparatus of claim 4, wherein the controller moves the transport and operates the articulator to apply the fiber bundle on the structure in a predetermined location.

18. The filament winding apparatus of claim 5, wherein the controller moves the transport and operates the winding head rotator to apply the fiber bundle on the structure in a predetermined location.

19. The filament winding apparatus of claim 1, wherein the structure is a fuselage for an aircraft.

LAW OFFICES
FINNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
WASHINGTON, DC 20005
202-408-4000

20. The filament winding apparatus of claim 1, wherein the fiber bundle has a gauge tow of less than 0.0038 inches.

21. A filament winding apparatus for winding a fiber bundle onto a structure, wherein the structure is supported by a mandrel, comprising:

a fiber bundle application section, wherein the fiber bundle application section further comprises:

a spool section, wherein the spool section further comprises:

at least one fiber bundle spool; and

an idler rod to control the tension in the fiber bundle;

an articulator to rotate the spool section; and

a winding head comprising a spreading assembly;

a resin applicator to apply resin to the fiber bundle;

a transport to move the fiber bundle application section; and

a controller for applying the fiber bundle on the structure.

22. The filament winding apparatus of claim 21, wherein the fiber bundle application section further comprises:

a winding head rotator to rotate the winding head.

23. The filament winding apparatus of claim 21, wherein the spreading assembly further comprises:

a plurality of rods arranged to spread each fiber bundle entering the winding head.

24. The filament winding apparatus of claim 22, wherein the winding head further comprises:

a frame having a top and bottom;

at least one winding eye disposed on the top of the frame; and

a roller disposed on the bottom of the frame.

25. The filament winding apparatus of claim 24, wherein the rods, winding eye, and roller are arranged to spread each fiber bundle entering the winding head and to arrange the spread tows in side-by-side parallel manner.

26. The filament winding apparatus of claim 23, wherein at least one of the rods is curved.

27. The filament winding apparatus of claim 23, wherein at least one of the rods rotates.

28. The filament winding apparatus of claim 21, wherein the resin applicator further comprises:

a resin container;

a resin hose connected to the resin container; and

a resin dispenser.

29. The filament winding apparatus of claim 27, wherein the resin container is heated.

30. The filament winding apparatus of claim 28, wherein the resin applicator further comprises a resin metering drum to instruct the resin container to provide a measured quantity of the resin to the resin dispenser.

31. The filament winding apparatus of claim 21, wherein the controller moves the transport, rotates the mandrel, operates the articulator, and operates the winding head rotator to apply the fiber bundle on the structure in a predetermined location.

32. The filament winding apparatus of claim 21, wherein the structure is a fuselage for an aircraft.

33. The filament winding apparatus of claim 21, wherein the fiber bundle has a gauge tow of less than 0.0038 inches.

34. An articulating winding head, comprising:

a frame having a top and bottom;

a plurality of spaced apart winding eyes disposed adjacent the top of the frame;

a plurality of rods arranged within the frame;

a roller disposed adjacent the bottom of the frame, the winding eyes, rods, and roller being arranged to spread a plurality of fiber bundles entering the winding head and to arrange the spread fiber bundles in side-by-side parallel manner for application to an object to be wound with fiber bundles.

35. The articulating winding head of claim 34, wherein at least one of the rods is curved.

36. The articulating winding head of claim 34, wherein at least one of the rods rotates.

37. The articulating winding head of claim 34, wherein there are three rods.

38. The articulating winding head of claim 37, wherein at least one of the rods is curved.

39. A method of filament winding a closed-shape structure, comprising:

providing a mandrel on which a fiber bundle can be wound;

providing at least one spool of a fiber bundle for a winding assembly configured to travel along a path substantially parallel to the axis of rotation of the mandrel;

feeding a fiber bundle from the spool through a winding eye;

conveying the fiber bundle through a rod assembly to spread the fiber bundle to a desired thickness; and

applying the fiber bundle to the mandrel.

40. The method of claim 39, further comprising:

applying resin to the fiber bundle in an area within the rod assembly.

41. The method of claim 39, wherein the rod assembly includes at least one straight non-rotating rod and at least one curved non-rotating rod, the fiber bundle traversing a path from the straight rod to the curved rod.

42. The method of claim 39, wherein the fiber bundle is applied to the mandrel in a manner that provides a substantially uniform skin thickness.

43. The method of claim 39, wherein applying further comprises:

applying the fiber bundle in a non-geodesic winding path.

44. The method of claim 39, wherein applying further comprises:

dividing the mandrel into at least two sections; and

applying the fiber bundle in a non-geodesic winding path within each section.

45. The method of claim 39, wherein applying further comprises:

applying the fiber bundle in a non-geodesic winding path on a portion of the mandrel; and

applying the fiber bundle in a non-geodesic natural winding path on the remaining portion of the mandrel.

46. The method of claim 39, wherein the mandrel is a fuselage for an aircraft.

47. The method of claim 39, wherein the fiber bundle has a gauge tow of less than 0.0038 inches.

48. A system for filament winding a closed-shape structure, comprising:

a first providing component configured to provide a mandrel on which a fiber bundle can be wound;

a second providing component configured to provide at least one spool of a fiber bundle for a winding assembly configured to travel along a path substantially parallel to the axis of rotation of the mandrel;

a feeding component configured to feed fiber bundle from the spool through a winding eye;

a conveying component configured to convey the fiber bundle through a rod assembly to spread the tow to a desired thickness; and

a first applying component configured to apply the fiber bundle to the mandrel.

49. The system of claim 48, further comprising:

a second applying component configured to apply resin to the fiber bundle in an area within the rod assembly.

50. The system of claim 48, wherein the rod assembly includes at least one straight non-rotating rod and at least one curved non-rotating rod, the fiber bundle traversing a path from the straight rod to the curved rod.

51. The system of claim 48, wherein the first applying component is configured to apply the fiber bundle to the mandrel in a manner that provides a substantially uniform skin thickness.

52. The system of claim 48, wherein the first applying component is further configured to apply the fiber bundle in a non-geodesic winding path.

LAW OFFICES
NNEGAN, HENDERSON,
FARABOW, GARRETT,
& DUNNER, L.L.P.
1300 I STREET, N. W.
VASHINGTON, DC 20005
202-408-4000

53. The system of claim 48, wherein the first applying component is further configured to

divide the mandrel into at least two sections; and

apply the fiber bundle in a non-geodesic winding path within each section.

54. The system of claim 48, wherein the first applying component is further configured to apply the fiber bundle in a non-geodesic winding path on a portion of the mandrel and to apply the fiber bundle in a non-geodesic natural winding path on the remaining portion of the mandrel.

55. The system of claim 48, wherein the mandrel is a fuselage for an aircraft.

56. The system of claim 48, wherein the fiber bundle has a gauge tow of less than 0.0038 inches.

57. A computer readable medium containing instructions for controlling a computer system to perform a method of filament winding a closed-shape structure, the method comprising:

providing a mandrel on which a fiber bundle can be wound;

providing at least one spool of a fiber bundle for a winding assembly configured to travel along a path substantially parallel to the axis of rotation of the mandrel;

feeding a fiber bundle from the spool through a winding eye;

conveying the fiber bundle through a rod assembly to spread the fiber bundle to a desired thickness; and

applying the fiber bundle to the mandrel.

58. A system for filament winding a closed-shape structure, comprising:

first providing means for providing a mandrel on which a fiber bundle can be wound;

second providing means for providing at least one spool of a fiber bundle for a winding assembly configured to travel along a path substantially parallel to the axis of rotation of the mandrel;

a feeding means for feeding a fiber bundle from the spool through a winding eye;

a conveying means for conveying the fiber bundle through a rod assembly to spread the fiber bundle to a desired thickness; and

an applying means for applying the fiber bundle to the mandrel.